REMARKS

Claims 1-15 and 17-20 remain in the application. By this amendment, claims 1, 2, 10-12 and 15, 17, and 18 have been amended, claims 3, 6, 7, 9, and 19 remain in original form, claims 4, 5, 8, 13, 14, and 20 were previously presented, and claim 16 was canceled without prejudice.

Referring to the Gleason reference, applicants' attorney apologizes for not citing the particular passage mentioned in Gleason showing the definition of the term "defect spatial signature." Applicants' attorney recognizes and appreciates the efforts by the Examiner in reviewing this reference.

It was stated in the Office action that while an applicant may be his own lexicographer of terms, the definition of such a term must appear in the applicant's own original specification in some form. It was further stated that the applicant may not seek to define an essential term found in the claims and specification simply by pointing to a prior art document. It is respectfully submitted that applicants have provided the Gleason reference not to act as their own lexicographer but rather to show that applicants use of the term "defect spatial signature" is consistent with its commonly accepted definition.

RESPONSE TO AMENDMENT

It was stated in the Office action that the term "defect spatial signature" is and must be interpreted from the three words that make up the phrase as a defect (defect) found somewhere (spatial) of some form (signature). It was further stated that as interpreted, the reference of Ferrell et al. reads on the claimed limitations argued by the applicants. Accordingly, applicants have amended the claims to better distinguish applicants' invention over the reference of Ferrell et al. It is believed the amendments to claims place them in condition for allowance which action is earnestly solicited.

REJECTION OF CLAIMS 1, 2, 10-12, 15, AND 16 UNDER 35 U.S.C. § 102(e)

Claims 1, 2, 10-12, 15, and 16 were rejected under 35 U.S.C. § 102(e) as being anticipated by Ferrell et al. (U.S. Patent No. 6,751,343) This rejection is respectfully traversed.

The Office action alleges that Ferrell et al. disclose in column 3, lines 55-64, column 1, lines 64-66, column 2, lines 53-64, and column 6, lines 6-13, a method for performing defect spatial signature analysis comprising creating a defect database of wafers having the defect spatial signatures, wherein the defect spatial signatures in the defect database are uncategorized. The Office action further states that Ferrell et al. disclose a method for evaluating defect spatial signatures in a semiconductor process in column 2, lines 55-59, column 3, lines 4-6, column 4, lines 64-67, column 5, lines 6-9, and column 2, lines 8-33 and 36-41. In addition, the Office action states that Ferrell et al. disclose a method for determining the occurrence of an anomalous event at column 2, line 65, and column 8, lines 13-30; storing a plurality of defect spatial signatures in a storage device at column 8, lines 16-18; and that the defect spatial signatures are uncorrelated and uncategorized at column 3, lines 30-33. It is respectfully submitted that Ferrell et al. teach in column 3, lines 50-64, that for each manufacturing-specific digital image in the selection, three independent feature vectors of manufacturing-based digital imagery can be extracted, the three independent feature vectors corresponding to a digital image modality and overall characteristic, a substrate/background characteristic, and an anomaly/defect characteristic, respectively. From the selection, at least one prototype vector can be calculated, the prototype vector corresponding to the particular characteristic of the manufacturing-specific digital image. Specifically, where three independent feature vectors of manufacturing-based digital imagery are extracted, each independent feature vector for each manufacturing-specific digital image in the selection can be logically combined, the logical combination forming the prototype vector for each independent feature vector.

Ferrell et al. teach in column 1, lines 64-66, that semiconductor manufacturing is representative of an industry that has a mature computer vision component for the inspection of product. Ferrell et al. teach in column 2, lines 53-64, that a method for

indexing and retrieving manufacturing specific digital images based on image content comprises three steps. First, at least one feature vector can be extracted from a manufacturing-specific digital image stored in an image database. In particular, each extracted feature vector corresponds to a particular characteristic of the manufacturing-specific digital image. The extracting step can comprise extracting three independent feature vectors, the three independent feature vectors corresponding to a digital image modality and overall characteristic, a substrate/background characteristic, and an anomaly/defect characteristic, respectively. Ferrell et al. teach in column 6, lines 6-13, a method for indexing a manufacturing-specific digital imagery that begins in step 10 of FIG. 3A. In step 12, the image extraction module 2 can load an image 8 stored in the image database 5. Notably, the image 8 needn't be stored in any particular database. Rather, in the preferred embodiment, all images 8 stored in the image database merely are organized in one file directory on a computer.

It was further stated in the Office action that Ferrell et al. teach in column 2, lines 60-65, that a feature vector can correspond to an anomaly/defect characteristic and that Ferrell et al. broadly disclose in column 3, lines 1-11, that a defect spatial signature describes a pattern of defects. Moreover, the Office action alleges that the applicants' claimed defect spatial signatures are effectively equivalent to the feature vectors used to describe the defects. Applicants respectfully disagree with this assertion. Ferrell et al. teach in column 2, line 36, and continuing to column 4, line 7, a method and apparatus for indexing and retrieving manufacturing-specific digital imagery based on image content by providing manufacturing-specific, context based image retrieval in an industrial environment. In response to an industrial event, Ferrell et al. claim their method can afford fast access to historical image-based records of similar industrial events so that a corrective action can be quickly taken. Thus Ferrell et al. provide a method and apparatus for employing an image based query-by-example method to locate and retrieve similar imagery from a database of digital imagery. The method of Ferrell et al. includes indexing and retrieving manufacturing-specific digital images based on image content that includes three steps using at least three steps. First, at least one feature vector can be extracted from a manufacturing-specific digital image stored in an image database. In particular, each extracted feature vector corresponds to a particular

characteristic of the manufacturing-specific digital image. The extracting step can comprise extracting three independent feature vectors, the three independent feature vectors corresponding to a digital image modality and overall characteristic, a substrate/background characteristic, and an anomaly/defect characteristic, respectively. Notably, the extracting step includes generating a defect mask using a detection process selected from the group consisting of thresholding the manufacturing-specific digital image, comparing the manufacturing-specific digital image with a golden template, and comparing the manufacturing-specific digital image with a digital image of a neighboring product; and extracting the feature vector for the substrate/background characteristic or the anomaly/defect characteristic using the defect mask. Moreover, the extracting step can comprise the steps of: distinguishing a defect-region from a non-defect region in the manufacturing-specific digital image; rendering the defect-region similar to the non-defect region based on an estimate derived from a region surrounding the defect-region, the removal of which forms a modified manufacturing-specific digital image; and extracting, a feature vector corresponding to the substrate/background characteristic from the modified manufacturing-specific digital image. Second, using an unsupervised clustering method, each extracted feature vector can be indexed in a hierarchical search tree. ... Finally, a second level data reduction based upon the prototype vector can be performed, the second level data reduction resulting in a subset of the feature vectors comparable to the prototype vectors, and further comparable to the query vector. Still, the retrieving step can further comprise the step of fetching from the image database a manufacturing-specific digital image defined by an intersection of the three independent feature vectors corresponding to the prototype vector.

The Office action further alleges that Ferrell et al. disclose that the defect spatial signatures are uncharacterized in column 6, lines 6-13, because it is taught that all the images may be indexed and simply stored in a single file and needn't be stored in any particular database. The Office action interprets this to mean that the spatial signatures or feature vectors are not characterized in any way and that they are all thrown together in one file as a list of items. As stated hereinbefore, Ferrell et al. teach in column 6, lines 6-13, a method for indexing a manufacturing-specific digital imagery that begins in step 10 of FIG. 3A. In step 12, the image extraction module 2 can load an image 8 stored in the

image database 5. Notably, the image 8 needn't be stored in any particular database. Rather, in the preferred embodiment, all images 8 stored in the image database merely are organized in one file directory on a computer. It is respectfully submitted that because Ferrell et al. teach organizing the images in one file directory they teach that the data are categorized. The act of organizing the images is tantamount to categorizing the images.

This contention is further supported by Ferrell et al. who teach in column 9, lines 48-56 that FIG. 6 shows a schematic representation of a hierarchically ordered set of feature vectors 106, v_i, i=1, 2, ...9. In the illustrated hierarchy, the vectors forming vector pair (v_3, v_1) have the most similar features to one another. Similarly, the features represented by vector pair (v_2, v_5) also have the most similar features to one another. The next closest pair of vectors (L_1, v_7) maintain a lesser degree of similarity than vector pair (v_3, v_1), where L_1 102 is the prototype of (v_3, v_1) at level 1 defined by the vector average, $\langle v_3, v_1 \rangle$. Here, Ferrell et al. are teaching categorizing the feature vectors by their most similar features. Thus, Ferrell et al. are clearly categorizing the feature vectors.

What is more, the Office action alleges that defect spatial signatures in the defect database are uncategorized data in that they correspond to unclassified defects (column 13, lines 3-5) and their arrangement in the HST is according to their relative similarity (column 9, lines 48-56), as opposed to some defect classification schema. Ferrell et al. teach in column 13, lines 1-9, that it is an object of their inventive method to provide end-user support for human-level assertions for sourcing manufacturing problems. Specifically, the inventive method can assist with off-line review and analysis of unclassifiable defects, provide assisted defect library generation for supervised automatic defect classification systems, provide unsupervised classification of defects during early yield learning, and, assist in training yield management personnel. Here, Ferrell et al. do not teach a database in which the defect spatial signatures are uncategorized data. Rather, Ferrell et al. teach a method for allowing human operators to review the data off-line so that it can be classified and entered into their database. Thus, it is believed that in this passage Ferrell et al. teach categorization of the data not at a computer level but at a human level, i.e., the human operator intervenes to determine a classification of the data.

It is respectfully pointed out that the argument in the Office action regarding arrangement in the HST according to their relative similarity is clearly stating that the defects are classified according to their relative similarity.

Ferrell et al. further teach in column 2, lines 8-33, that the semiconductor industry currently has no direct means of searching the yield management database using image-based queries. The ability to query the fabrication process is based primarily on date, lot, and wafer identification number. Although this approach can be useful, it limits the user's ability to quickly locate historical information. For example, if SEM review has determined that a particular defect or pattern problem exists on a wafer, the yield engineer must query on dates, lots, and wafers to find similar historical instances. Although roughly 70% of all space occupied in the database consists of imagery, queries to locate imagery are manual, indirect, tedious, and inefficient. Therefore, this becomes an iterative and slow process that can prove unwieldy in the modern semiconductor environment where a single manufacturing campus having multiple fabrication facilities at one site can generate thousands of images daily. If a query method can be designed that allows the user to look for similar informational content, a faster and more focused result can be achieved. A process for locating similar imagery based on image content, for example the image structure rather than the lot number, wafer identification, and date, would result in a reduced time-to-source. Thus, it is respectfully submitted that contrary to the allegations in the Office action Ferrell et al. do not teach defect spatial signature analysis of a semiconductor process. Rather, Ferrell et al. are teaching that semiconductor manufacturers have relied on using lot number, wafer identification, and date to search their databases and that this method is slow and cumbersome. Indeed, Ferrell et al. teach that because of the disadvantages of the techniques semiconductor manufacturers had been using, a method for manufacturing-specific CBIR that addresses defect analysis, product quality control, and process understanding in the manufacturing environment was needed.

To accomplish their goal, Ferrell et al. teach in column 2, line 36, and continuing to column 4, line 7, a method and apparatus for indexing and retrieving manufacturing-specific digital imagery based on image content by providing manufacturing-specific, context based image retrieval in an industrial environment. In response to an industrial

event, Ferrell et al. claim their method can afford fast access to historical image-based records of similar industrial events so that a corrective action can be quickly taken. Thus Ferrell et al. provide a method and apparatus for employing an image based query-by-example method to locate and retrieve similar imagery from a database of digital imagery. The method of Ferrell et al. includes a method for indexing and retrieving manufacturing-specific digital images based on image content that includes three steps using at least three steps. First, at least one feature vector can be extracted from a manufacturing-specific digital image stored in an image database. In particular, each extracted feature vector corresponds to a particular characteristic of the manufacturing-specific digital image. ... Second, using an unsupervised clustering method, each extracted feature vector can be indexed in a hierarchical search tree. ... Finally, a second level data reduction based upon the prototype vector can be performed, the second level data reduction resulting in a subset of the feature vectors comparable to the prototype vectors, and further comparable to the query vector. Still, the retrieving step can further comprise the step of fetching from the image database a manufacturing-specific digital image defined by an intersection of the three independent feature vectors corresponding to the prototype vector.

Applicants, on the other hand, teach on page 3, lines 8-28, a method for electronically searching a database to determine if a spatial signature has occurred before and, if so, notifying an engineer. ... In a beginning step identified by reference number 21, an electronic wafer map for a first wafer having a defect associated therewith is generated. In a next step (reference number 23), the electronic wafer map of the first wafer is partitioned into defect regions or areas by identifying local densities of defects, i.e., the defects are clustered using mathematical clustering techniques or using a stylus and a pad. Briefly referring to FIG. 4, a wafer map 16 of a defect spatial signature having a cluster boundary 17 is illustrated. The clustering is accomplished using a stylus and pad coupled to a computer system displaying an image of the defect spatial signature. By way of example, the defects are caused at a furnace operation in a semiconductor manufacturing process. The wafer map is stored in a relational database (reference number 25), such that the relationship of the defects to each other are stored in a row and column format. In other words, coordinates of the process signature for each defect are

stored in the database thereby creating a relational database. For example, the coordinates of the process signature of a first defect are stored in the relational database and the coordinates of the process signature of a second defect are stored in the relational database. The wafer map of the first wafer is reconstructed from the relational database (reference number 29) and the wafer maps of the two wafers are electronically analyzed to determine if the wafer map of the first wafer correlates to that of the second wafer within a predetermined confidence level (reference number 31). If a match within the predetermined confidence level occurs, then the computer reports that a match has been encountered.

Accordingly applicants' claim 1 calls for, among other things a method for performing defect spatial signature analysis of a semiconductor process comprising creating a defect database of wafers having defect spatial signatures, wherein macroscopic spatial patterns at the wafer level are absent from the defect database and determining if the recent macroscopic defect spatial signature corresponds to at least one of the defect spatial signatures reconstructed from the defect locations in the defect database. Claim 10 calls for, among other things generating a database of defect locations from multiple individual wafers, wherein macroscopic spatial patterns on the wafers have not been identified and determining if the at least one macroscopic spatial signature on the inspected wafer matches a spatial pattern reconstructed from the database of defect locations. Claim 15 calls for, among other things, storing a plurality of defect coordinate data in a storage device, wherein the defect locations are uncorrelated and wafer level patterns of the defect locations have not been identified and determining if the recent identified wafer level spatial signature corresponds to one of the spatial patterns identified through reconstructing and analyzing the defect locations on wafers held in the storage device. At least these limitations of applicants' amended claims 1, 10, and 15 are not included in the relied on reference of Ferrell et al. Because all limitations of applicants' claims 1, 10, and 15 are not included in the relied on reference of Ferrell et al., it cannot anticipate applicants' claims 1, 10, and 15.

Claim 2 depends from claim 1 and is believed allowable over the relied on reference of Ferrell et al. for at least the same reasons as claim 1. Claim 2 further sets out that the defect database contains defect coordinates, and wherein identification of wafer

level spatial relationships between the defect coordinates is absent. At least this limitation of claim 2 is not included in the relied on reference of Ferrell et al., further precluding anticipation of applicants' claim 2.

Claims 11 and 12 depend from claim 10 and are believed allowable over the relied on reference of Ferrell et al. for at least the same reasons as claim 10. Claim 12 further sets out that the macroscopic spatial signatures are uncategorized. At least this limitation of claim 12 is not included in the relied on reference of Ferrell et al., further precluding anticipation of applicants' claim 12.

Although claim 16 was rejected in the Office action, it was canceled without prejudice in an amendment mailed to the United States Patent and Trademark Office on November 19, 2005. Accordingly, the rejection of claim 16 is moot.

REJECTION OF CLAIMS 3-5, 8, 13, 14, AND 18-20 UNDER 35 U.S.C. § 103(a)

Claims 3-5, 8, 13, 14, and 18-20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Farrell et al., in view of La et al. (U.S. Patent No. 5,761,064). This rejection is respectfully traversed.

Claims 3-5 and 8 depend either directly or indirectly from claim 1 and are believed allowable over the relied on references, either singly or in combination, for at least the same reasons as claim 1. It is respectfully submitted that La et al. teach in column 7, lines 2-12, that the defect wafer map shows each individual die and a dot on each die in which there is a defect. The user can select any defect on any die for further examination by double-clicking on that defect. For example, defect map 140 shows a representative defect 144 which has been double-clicked (indicated by arrows 146) for further examination. The next chart generated is a defect optical image chart 148 of the defect in the selected die. The next chart generated is a scanning electron microscope (SEM) image 150. The user can then select a spectral analysis chart 152 of the wafer selected. It is respectfully submitted that La et al. do not teach or suggest storing coordinates of a process signature, but coordinates of individual defects. Claim 4, on the other hand, further sets out storing coordinates of a process signature of a first defect and storing coordinates of a process signature of a second defect from each wafer, wherein

the spatial orientation of the coordinates of the process signatures of the first and second defects are in relation to each other. At least this limitation of claim 4 is not taught or suggested by the relied on references of Ferrell et al. or La et al., taken alone or in combination, further precluding obviousness of claim 4.

Claims 13 and 14 depend either directly or indirectly from claim 10 and are believed allowable over the relied on references, taken alone or together, for at least the same reasons as claim 10.

Claims 18-20 depend either directly or indirectly from claim 15 and are believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 15. Claim 19 further sets out storing coordinates of process signature of a first defect and storing coordinates of a process signature of a second defect, wherein the coordinates of the process signatures of the first and second defects are in relation to each other. At least this limitation of claim 19 is not taught or suggested by the relied on references of Ferrell et al. or La et al., taken alone or in combination, further precluding obviousness of claim 19.

<u>REJECTION OF CLAIM 6 UNDER 35 U.S.C. § 103(a)</u>

Claim 6 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of Jain et al. (U.S. Patent No. 5,893,095). This rejection is respectfully traversed.

Claim 6 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

<u>REJECTION OF CLAIMS 7, 11, AND 17 UNDER 35 U.S.C. § 103(a)</u>

Claims 7, 11, and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of Tobin et al. (U.S. Patent No. 6,535,776). This rejection is respectfully traversed.

Claim 7 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

Claim 11 depends from claim 10 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 10.

Claim 17 depends from claim 15 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 15.

REJECTION OF CLAIM 9 UNDER 35 U.S.C. § 103(a)

Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of the applicants' admitted prior art, as disclosed in the Applicants' Background of the Invention. This rejection is respectfully traversed.

Claim 9 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

CONCLUSION

No new matter is introduced by the amendments herein. Based on the foregoing, applicants believe that all claims under consideration are in condition for allowance. Reconsideration of this application is respectfully requested.

Respectfully submitted,

Dated: 7 February 2006

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